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The policymaking process for creating competitive assets for the use of biomass energy: the Brazilian alcohol programme

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Abstract

Public policies are fundamental to spur the use of biomass and make it competitive to face traditional commercial fossil fuels. This article analyzes the policymaking process of the Brazilian National Alcohol Policy (Proalcool). Proalcool is one of the world's most ambitious efforts to produce a renewable biomass fuel as an oil substitute. In the 1970s, after the oil crisis and the sharp increase in fuel prices, the Brazilian government started intensifying its policy to substitute sugarcane alcohol for gasoline in automobile use. Through a set of governmental interventions to increase alcohol demand and supply, Brazil created some competitive assets that made Proalcool a relative success in terms of developing institutional and technological capabilities for using renewable energy in large scale. Several key actors influenced the policy directions, such as the central and state governments, military groups, the alcohol industry, sugarcane agricultural aristocracy, bureaucrats, researchers and the media. Instead of thinking of Proalcool as a government decision based only on economic rationale or interests of few decision-makers, the elaboration and implementation of this alcohol policy could be thought of as the result of a policymaking process where the different stakeholders involved in the process with their values, interests and knowledge interacted with each other according to the political, social, technological and economic situation.

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Contents

1. Introduction: a short history of alcohol in Brazil

The need to increase the use of renewable energy is fundamental to make the world energy matrix more sustainable [1,2]. An increasing supply of renewable energy will depend on a growing domestic and industrial demand for this kind of energy. The Brazilian alcohol program is an example of how government interventions can create a market for and spur the use of renewable energy.

Brazil is probably the country that has furthest gone with regard to large scale use of alcohol in the automobile fuel sector. Alcohol as a fuel has a long history in Brazil. Public policies were fundamental in spurring the use of renewable energy. The first official alcohol policy was established in 1931, and since then, several attempts were made to mix alcohol (anhydrous) with gasoline to fuel Brazilian automobiles [3]. However, the oil crises in the 1970s led the military government[1] to start promoting the use and production of alcohol intensively. Initially, in the 1970s, the government created the Brazilian National Alcohol Program (Proalcool) and intensified the use of gasohol (a mixture of ethanol and gasoline) to fuel common gasoline cars. Then, since 1980, automobile factories have produced alcohol-fueled cars. In the middle of the 1980s, in the apex of the alcohol era, more than 90% of the total sales of passenger cars was alcohol-fueled cars. Today, even with the alcohol crisis, they still correspond to about 20% of the national automobile fleet. This makes Brazil one of the few countries in the world that has managed to separate a significant part of the automobile industry from petroleum dependency.

[1] Brazil had a nationalist military government between 1964 and 1985. The executive power was controlled by military forces but the legislative had it members elected directly from the parties allowed by the military power.

This big transformation of the Brazilian fuel structure was the result of enormous efforts of the state:

(i) by shaping the agricultural and industrial policies for achieving the goals of the program;
(ii) by investing public resources in research;
(iii) by regulating and giving incentives to the private sector to pursue innovation and invest in alcohol related activities;
(iv) by giving incentives to car owners to shift to alcohol fueled cars, thus increasing the demand for alcohol.

Through tremendous subsidies, the Brazilian government induced the public and the private sector in the alcohol activity to undertake the necessary projects for the expansion of the alcohol industry, such as building distilleries, expanding sugarcane production, retooling automobile plants and buying alcohol-powered cars. All these government incentives for Proalcool led to many technological improvements and increase in productivity in the alcohol-related industry, which contributed to the relative success of the plan. The government expected to withdraw the subsidies when oil prices had achieved a certain level that would make the whole alcohol program profitable, but that has never happened. After the big drop in oil prices in the middle of the 1980s, the pace of Proalcool's implementation slowed down in the 1990s [4]. However, alcohol still is important in the automobile fuel market and has good future prospects as the oil prices increase again and strategies for combating global warming become relevant. Brazil has the competitive advantage of having developed a renewable energy alternative to automobile use. The understanding of how the Proalcool policymaking process occurred is fundamental to design future public policies to spur the use to renewable energy.

2. The policymaking process in Proalcool

In the middle of the 1970s, oil prices were extremely high. Moreover, specialists all over the world forecast that oil prices would significantly rise in the following years, previewing a possible era of oil scarcity in the future. Also, fuel demand in Brazil was increasing as the economy was growing at a fast pace [5]. Brazilian policy-makers and part of the general public saw these predictions as catastrophic signs once Brazil was completely dependent on oil imports at that time.

During the same time, sugarcane activities, which were among the main national economic activities, were in crisis [6]. Sugarcane prices were low, and there were huge surpluses in sugarcane production and processing capacity. These factors led groups with strong interests in sugarcane activities such as, sugar industrialists and sugarcane farmers to pressure the government to try to find alternatives to avoid their general bankruptcy. Strengthening the national use of alcohol was one of these alternatives. These interests imagined a strong alcohol policy as a possible panacea for the crisis in their sugarcane sector. The pressure on the executive and legislative

was based on strong government and political connections of many sugarcane industrialists and their economic importance for the country. Also, many state governments, whose economies were dependent on sugarcane, joined these sugarcane interests in their efforts to pressure the federal government to help to save the sugarcane economy.

On the other hand, parts of the military government and military groups outside the government had continuously pursued a strategy of self-sufficiency in key inputs, especially fuel [7,8]. With their strong values about national security and the need for national self-sufficiency, the military sectors saw the oil crisis allied to the high dependency of the country on the world fuel market as a threat to national sovereignty. Producing alcohol would be part of the solution to achieve self-sufficiency in the fuel sector (the other part was the intensification of petroleum exploration and exploitation in national territory, which led to a high increase in oil production in the last two decades [9]). Their powerful position in the national government transformed these strong values into another strong interests in the national policymaking arena for adoption of an alcohol policy.

Researchers in state laboratories and universities formed another group interested in the development of a national alcohol program. During that nationalistic period, some researchers had strong values about the need to develop national technology to avoid technological dependency on the industrialized countries. They had firm beliefs that they could develop the technology for alcohol engines, if there was a need and they had the resources. In the 1970s, in the Center for Aerospace Technology in São Paulo State, the first results of the experiments with Otto-cycle internally combusted engines for alcohol proved to be very successful and encouraged the government to invest more in alcohol research. The overall enthusiasm in the possible technological independence of Brazil for car engines made possible the action of researchers to push for more significant advances in the establishment of a comprehensive national alcohol policy.

During this period, the media frequently showed the possible consequences of a national oil crisis and the development of an alcohol policy as a possible alternative for facing this crisis. Also, the public was worried about the constant increases in fuel prices and about the possibility that an oil crisis could paralyze the country. The population in general was supportive of an alcohol policy, which could be the key for cheap fuel and economic stability. The only groups skeptical about alcohol policies were oil companies (national and multinational companies) and the automobile factories, which worried about state regulations on the number of alcohol-fueled cars produced. However, they did not have any reasonable solution for the imminent crisis, and the groups that favored alcohol policy were very powerful actors that were very influential in the process of policymaking. Also, these groups opposing a firm alcohol policy received substantial incentives to calm down their concerns.

In sum, such an equation of group and national interests and values was also supported by a straight line of economic reasoning [10] from the economists, both technocrats in the government and professionals in the private sector:

(i) world oil prices had quadrupled in the previous ten years;

(ii) current account deficits and inflation were high and income growth was slow;
(iii) alcohol production would ultimately reduce sugar surplus and petroleum imports, so safeguarding national sovereignty;
(iv) reduction in petroleum imports would help Brazil to adjust to the OPEC oil shock by saving foreign exchange, reducing inflation, and enhancing income growth;
(v) Brazil had been developing the technology for using alcohol, which could put alcohol-fueled cars in the market very soon.

Economists in the government were anxious because of the increasing national deficit due to the rise of value of the oil imports. No short-term solution could come to their minds, and the collapse of the national economy seemed imminent. They would support any idea that could seem reasonable for combating the crisis ("during crises, ideas are more likely to be adopted" [11]). Therefore, under all the circumstances described above, the government with the support of the Congress, under pressure of all interest groups and facing a fuel crisis, decided to create Proalcool.

3. The program

The Proalcool was created in 1975 to concentrate all the national efforts to increase the alcohol production and use. It basically consisted of two phases. During phase one (1975–1979), the government policies searched to facilitate both distillery expansions and higher conversion rates in the mixture gasoline–alcohol. In phase two, from 1980, the Brazilian government kept authorizing and subsidizing the vast expansion of sugarcane production capacity and industrial investments in mills and in distilleries. Also, automobile factories started to produce only-alcohol-fueled cars with the technology developed in the universities and research centers.

In phase one, the alcohol program was a response to high oil prices, sugar low prices and surplus production. More anhydrous alcohol was mixed to gasoline. The Brazilian long experience with mixed fuel showed that conventional gasoline engines could efficiently operate using a mixture of up to 20% of anhydrous alcohol. If this maximum limit (20%) were reached the alcohol production would have to increase from 600,000 liters per year to 3 billion liters per year [3]. Also, the government started giving subsidies to expand distilleries. In this phase, there was no rigid commitment to supplying alcohol intensively, since the proportion of alcohol in the mixture could vary without affecting car efficiency and alcohol production was still low. It would be only a question of tradeoff between sugar and alcohol production. If the sugar prices fell, sugar production could be shifted to alcohol, or vice-versa, without affecting the consumers and without large adjustment costs.

Different from phase one, phase two introduced the use of alcohol-fueled cars. In 1980, Brazilian car factories started to release the first models of alcohol-powered cars. The technology for these cars was primarily developed at public research centers in the 1970s, and then passed to the private sector, which keeps developing it. Moreover, autonomous alcohol-only processing plants were built using government

subsidies to achieve the agricultural output necessary to fulfill future demand for alcohol. These plants cannot produce sugar as an alternative end product. Therefore, at this point, the situation of the alcohol program became irreversible, once part of the market depended exclusively on alcohol to fuel their cars, and the alcohol production could not be completely shifted to sugar.

In both phases of Proalcool, government interventions were very important to increase alcohol production and consumption, as well as to develop alcohol technology. These interventions had very significant results in increasing alcohol competitiveness face other fuels.

4. Incentives to alcohol activities

Proalcool came as a mix of distributive and regulatory policies [12]. On the one hand, the government distributed several incentives to alcohol related activities, satisfying the demands of many interest groups that influenced the adoption and implementation of an alcohol policy. On the other hand, regulations were adopted to make automobile industries to produce alcohol-fueled cars and to make fuel distribution companies to work with alcohol. The primary purposes of these incentives and regulations were to create and keep a market for alcohol, to increase alcohol production and to foster technological development in the alcohol sector. Thus, the government was trying both to increase demand and supply of alcohol related activities. Succinctly, the main incentives in the Proalcool program have been the following:

- *Subsidies to the industrial and agricultural sectors.* Cheap credit was a very important subsidy to alcohol activities. The Brazilian government offered credit for agricultural and industrial investments in alcohol production at interest rates well below the market rate. Other features of credit contract, such as a sizable grace period, made the incentives even greater.
- *Protection against alcohol imports.* The Brazilian government secured that all production of alcohol was commercialized at a price above the minimum price, and imports are not allowed in normal situations. Thus, sugarcane entrepreneurs had guaranteed that if they invested in the expansion of alcohol production, they would have a market for it.
- *Subsidies to consumers.* To ensure that alcohol production was absorbed by the market, alcohol pumps had to be installed at all gas stations, and the government guaranteed, through price control, alcohol prices per mileage much lower than the gasoline prices. These factors stimulated sales of alcohol-powered cars and ensured car owners that they would have a secure supply of cheap fuel for a long period.
- *Incentives to research on alcohol related fields.* Many universities, research institutes and companies were given incentives to undertake research on alcohol related activities. As we are going to discuss later, these activities range from

biotechnology for genetic improvement to mechanical engineering for the development of engines.

All these government actions to create an alcohol market resulted in a growing market and gains in productivity, besides other advantages Brazil had to make alcohol a viable renewable energy alternative.

5. Increasing alcohol competitiveness

Brazil has innately had and created through the incentives described above many factors that increase the competitiveness of alcohol face other fuels, which could be called competitive assets[2]. Brazil had some of these factors when the alcohol program was started, and government intervention created many others that are important in making alcohol a more economically, socially and environmentally fuel alternative. Government policies were fundamental to induce a leapfrog alcohol technology and increase alcohol efficiency and competitiveness [14]. The following competitive assets could be mentioned — many of them were created by the government incentives.

(i) *Brazil is endowed with large dimensions of agricultural land and climate appropriate to the development of sugarcane plantations.* This is a competitive asset (raw material) once not many countries have these special conditions to sugarcane production.
(ii) *Sugarcane and alcohol activities have a long history and tradition in Brazil.* Before Proalcool started, many techniques in the alcohol field were already well developed in Brazil. This is another comparative advantage that has helped to improve alcohol production during Proalcool.
(iii) *Environmental externalities can create competitive advantage.* First, the combustion of alcohol causes much less local pollution than gasoline (alcohol does not produce SO_x, and produces less other pollutants, such as CO). This has contributed to a decrease in the pollution index of SO_x in many Brazilian metropolises [15]. Second, alcohol is a renewable resource from biomass, so the net production of CO_2 is zero, hence, it does not contribute in aggravating the Greenhouse effect. Therefore, as the world has become more aware of the possible negative environmental effects of the use of fossil fuels, people and governments have valued more renewable sources of energy. The implementation of directives in the Kyoto Protocol can spur such gains in the future.
(iv) *Improvement in sugarcane production.* The productivity of sugarcane has increased per hectare [16]. First, producers are investing in new agricultural tech-

[2] Competitive assets consist of anything that added to competitiveness of the product: “raw materials, physical capital, “social capabilities”, in the form of labor skills or managerial expertise, and proprietary technology”, as defined in Amsden [13].

niques and mechanization. Second, genetic improvement in sugarcane has been done using biotechnology research that is undertaken in many universities and institutes (private and public). Also, government and sugarcane producers have made considerable efforts to diminish the environmental effects of the sugarcane activities, such as using less environmentally damaging harvest methods and controlling the release of byproducts [17]

(v) *Improvement in distillery process.* The process of fermentation to produce alcohol from sugarcane has been technically improved, increasing productivity in the distilleries. This improvement is the result of genetic improvement of the yeast used in the fermentation and of change in the general fermentation process from discontinued to continued fermentation, due to research achievements [18].

(vi) *Development of the use of byproducts.* In the beginning of Proalcool, many byproducts of sugarcane and alcohol production, such as bagasse[3] and vinhoto,[4] were not used (they were dumped or burned). However, along the years, with innovations, bagasse has become a useful burning fuel for furnaces and co-generation, and vinhoto has become an excellent fertilizer, both with good commercial value [17]. So these former byproducts are now adding to the competitiveness of alcohol.

(vii) *Development of alcohol-powered engine technology.* Brazil has continuously developed the technology of the Otto-cycle internally combusted engines for alcohol. The research started in 1970s in the Center for Aerospace Technology (CTA) in São Paulo and is now developed in many universities, technology research centers and automobile companies. This research has helped to increase the engine efficiency. Also, other parts of the car have constantly been innovated, which positively affect car durability and reduction in costs of maintenance, such as the improvement of startup mechanism, the anticorrosive carburetor and tank, and alcohol filtering. A buildup in the capacity of the mechanics to work with alcohol-powered cars could be mentioned as another technical improvement that has occurred along the time.

6. Has the alcohol program succeeded?

In 1989 the Brazilian alcohol production reached 11.7 billions of liters, in the 372 distilleries all over the country [18]. Alcohol fueled more than 4.5 million alcohol-powered cars and partially the rest of the 9.5 million gasoline fleet (since in Brazil a mixture alcohol–gasoline is used to fuel gasoline cars). In 1992 sugarcane products (alcohol and bagasse used as burning fuel) still represented more than 10% of the total energy consumption in the energy matrix [19]. In 1999 the alcohol production reached 14 billion liters [20]. The government plans to keep the consumption of

[3] Bagasse is the sugarcane body waste after the juice is extracted.

[4] Vinhoto is a by product of the alcohol distilling process that was used to be dumped in the water streams.

alcohol in the transportation system around 22% of the matrix and increase the sales of alcohol-powered cars in order to consume the alcohol produced by the installed distillery capacity. Therefore, alcohol became and is going to stay part of the Brazilian fuel structure, unless for medium term.

In the short term, the success of Proalcool is debatable [21]. Despite all the economic costs it has demanded, Proalcool has developed a new economic activity whose impacts cannot be predicted by a pure direct cost-benefit analysis. They include indirect economic impacts (such as jobs), improvement in technology and human capability and environmentally beneficial impacts. Also, many factors that affect alcohol competitiveness are unpredictable, such as oil prices in the medium and long run and technological breakthroughs. Therefore, if Proalcool is managed properly, it possibly has chances to be successful and to put Brazil at a big advantage in the world market for renewable energy in the long term.

From the economic perspective, the success of Proalcool is questionable. Oil prices, once expected only to rise, fell tremendously in most of the 1990s, making Proalcool continuously dependent on government subsidies. As oil prices increase again, since the end of the 1990s, alcohol can even become more price competitive than oil. Technically, Proalcool is a superlative success. As we saw, over the years, it has built technological improvements that have helped alcohol activities to become more economically efficient and less environmentally damaging. Some of these technological improvements were achieved before the expected time and with costs below the estimate [16].

Issues of environmentally sustainable development were not directly at stake when the government planned Proalcool. However, it certainly serves as a good example of how to create the organizational capacity and to give the proper incentives for making viable the large-scale use of a renewable energy from biomass, which is one of the alternatives for pursuing a sustainable energy strategy.

7. The interaction between interests, values and knowledge

Interests, values and knowledge were important concepts for understanding the alcohol policy in Brazil. In the beginning, this policy could be superficially seen as a pure result of interest groups in an appropriate occasion (oil crisis), or a “window of opportunity” [22]. In this line, these interest groups simply took advantage of their privileged positions and contacts in the government to influence the adoption of a policy that favored their own interests. However, as one analyzes the policymaking process more closely, one could clearly see the presence of all three key concepts and the interaction among them. All three concepts were fundamental for explaining the process of policymaking in Proalcool, and were intertwined in the process of policymaking.

Knowledge was important in influencing the policymaking process. The two most influential kinds of knowledge in the policy process were the knowledge generated by economic experts of a possible crisis and the knowledge of the technical capacity of the Brazilian researchers to develop alcohol-powered engines. Knowledge was

also fundamental to persuade the economists and military forces in the government to definitively make their minds about the adoption of the policy.

Values were especially present in the military groups and in the research communities. Military groups had strong values concerning the national security and self-reliance. At that time, experts (with their knowledge) previewed a future oil crisis. Because alcohol could possibly provide Brazil with fuel self-sufficiency and then avoid the crisis, the military values along with the knowledge about a possible crisis generated interest groups in favor of an alcohol policy. Researchers had strong values over the need to develop a national technology for engines. These values were reinforced by the positive results of the first experiments with alcohol engines (knowledge). Researchers became another interest group in the policy arena.

Interests certainly were overly important to influence the alcohol policy. Besides the interests described above, the strong interests of the sugarcane industrialists, sugarcane farmers and state governments with their connections were key in developing Proalcool. Moreover, the role of interests in explaining the policy making were especially significant in this case, since at that time Brazil was under a dictatorship, and policies were made in relatively closed political circles, where only privileged organized interests had access and voice [23].

As mainly a distributive policy, Proalcool could be characterized as a kind of “log-rolling”. The different groups that pressured and supported the government to adopt the policy received enormous benefits in form of subsidies and resources. This confirms Lowi predictions for a distributive policy [12]. However, in this case of dictatorship, differently from the pluralism environment analyzed by Lowi, the log-rolling was not in exchange for vote, but it was in exchange for political support for keeping the dictatorship alive. With the democratization of the country, Proalcool has continued to receive support from the government because of its importance to diminish Brazilian dependency on imported fuels. For example, recently (2001), after an accident in an important rig of Petrobras (the Brazilian state oil company) that diminished production, the percentage of anhydrous alcohol in gasoline was increased to avoid imports of oil.

8. Conclusions

The Brazilian government started building up some competitive advantages to sugarcane alcohol use as an automobile fuel by investing in technology research, creating an alcohol industrial policy and offering incentives for the private sector. In the short term, with low oil prices, the alcohol program could be seen as one more “undesirable government intervention in the fuel market”. However, the economic context of the 1970s can justify Proalcool as a reasonable policy to attempt to deal with oil crisis. Also, as the world has become more environmentally conscious and oil becomes scarce and expensive in the future, alcohol is a real option for worldwide substitution of liquid fossil fuel and can be an important alternative to achieve reductions in CO_2 emissions [24]. Brazil has built some competitive assets that can put it in a privileged situation in the market of alcohol production and

technology in the long term. This case shows the importance of public policies in allowing the creation of a market for renewable energy. Thus, the Proalcool supports the belief of some authors about the necessity of supportive public policies to spur green energy markets [25].

Proalcool reveals that mechanisms for implementing economic and technology policies, though significantly complex and uncertain, can lead the private sector, and society in general, towards the accomplishments of planned national or environmentally sustainable goals. On the other hand, Proalcool's decline in economic competitiveness due to the fall in oil prices in the 1990s illustrates the difficulties of long-range planning, which is one of the key points for planning sustainable development strategies.

Although apparently only interests were sufficient for explaining the policy making process, there were powerful interactions among the three concepts in the policymaking process of Proalcool. As we saw before, knowledge was important to reinforce values that, in turn, became strong political interests in the policymaking arena (military and research interests). These interests along with other strong interests (sugarcane interests), knowledge and values were all important factors for definitively explaining the adoption and implementation alcohol policy. Nowadays, as environmental interests and values are much stronger, public policies towards the use of renewable energy policies are likely to receive much support.

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